CLAIMS

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A system for providing a dynamically spectrally tailored Raman pump, said Raman pump being operable to generate Raman gain for a plurality of signal wavelengths, said system comprising:

a Raman pump source including a plurality of gain elements, said Raman pump source being operable to generate said Raman pump;

a plurality of current sources, each current source being coupled to at least one gain element of said plurality of gain elements such that said at least one gain element operates at a respective variable optical power level;

a spectral content detector being operable to provide power information regarding optical power levels associated with said plurality of signal wavelengths; and

a control unit being operable to control said plurality of current sources utilizing in part signal power information provided by said spectral content detector.

2. The system of claim 1 wherein said Raman pump source includes:

an external cavity being operable to provide feedback to said plurality of gain elements and to combine output beams from said plurality of gain elements to form said Raman pump.

3. The system of claim 2 wherein said external cavity includes:

a collimating optical assembly;

a dispersive element; and

a partial reflector.

4. The system of claim 3 wherein said partial reflector is embedded in an optical fiber, said system further comprising:

a fiber coupling lens being operable to couple combined output beams from said external cavity into said optical fiber.

5. The system of claim 3 wherein said dispersive element comprises at least one item from the list of:

reflective diffraction grating;

transmission diffraction grating;

prism; and

hologram.

6. The system of 2 wherein said external cavity comprises an optical wavelength multiplexing element selected from the list of:

an arrayed waveguide grating; and

a Mach-Zehnder interferometer.

7. The system of claim 3 wherein said collimating assembly includes a micro-lens array operable to adjust divergence of each of said output beams from said plurality of gain elements.

8. The system of claim 1 wherein said spectral content detector is a spectrum analyzer.

9. The system of claim 3 wherein said spectral content detector is a linear array detector associated with said dispersive element of said external cavity.

10. The system of claim 3 further comprising:

a linear array detector, said linear array detector including a plurality of discrete detectors;

a focusing lens;

said dispersive element generating zero order diffraction beams from said output beams; and

said focusing lens being operable to focus said zero order diffraction on to said linear array detector.

11. The system of claim 3 further comprising:

a detector;

a focusing lens;

said partial reflector being operable to provide a feedback beam;

said dispersive element being operable to generate a zero order diffraction beam from said feedback beam; and

a focusing lens being operable to focus said zero order diffraction beam on said detector.

12. The system of claim 1 wherein said control unit includes:

a processor executing code; and

code for analyzing said optical power levels associated with said plurality signal wavelengths to determine each respective variable optical power level.

13. The system of claim 12 wherein said code for analyzing includes code for building a differential gain matrix, wherein said differential gain matrix relates a change in power levels associated with said plurality of gain elements to a change in power levels associated said plurality of signal wavelengths.

14. The system of claim 13 wherein said power levels associated with said plurality of gain elements are measured by current levels applied to said plurality of gain elements.

15. The system of claim 13 wherein said power levels associated with said plurality of gain elements are measured by a linear detector array which receives output beams from said plurality of gain elements.

16. The system of claim 13 wherein said code for analyzing includes code for inverting said differential gain matrix to produce an inverted matrix.

17. The system of claim 16 wherein said code for analyzing includes code for multiplying said inverted matrix by a desired power level change vector to determine changes in power levels to be applied to said plurality of gain elements.

18. The system of claim 12 wherein said code for analyzing implements a learning algorithm.

19. The system of claim 12 wherein said code for analyzing applies a number of current combinations to said plurality of current sources to determine optimal current levels.

20. The system of claim 1 wherein said plurality of signal wavelengths are within wavelength range of 1530 nm to 1565 nm.

21. The system of claim 1 wherein said plurality of signal wavelengths are within wavelength range of 1570 nm to 1610 nm.

22. The system of claim 1 wherein said plurality of signal wavelengths are within wavelength range of 1430 nm to 1530 nm.

23. The system of claim 1 wherein said plurality of signal wavelengths are within wavelength range of 1615 nm to 1660 nm.

24. The system of claim 1 wherein said plurality of gain elements comprises at least one semiconductor material from the list of:

GaAlAs;

GaAs;

InGaAs;

InGaAsP; and

AlGaInAs.

25. The system of claim 1 wherein said plurality of gain elements are one item from the list of:

edge emitter;

vertical cavity surface emitting laser; and

grating surface emitting laser.

26. A method for providing a dynamically spectrally tailored Raman pump, said Raman pump generating Raman gain for a plurality of signal wavelengths, said method comprising the steps of:

providing a plurality of gain elements, said plurality of gain elements being operable to generate said Raman pump;

driving said plurality of gain elements utilizing a plurality of current sources, each current source of said plurality of current sources being operable to drive at least one gain element of said plurality of gain elements by a variable current;

providing said Raman pump to an optical medium;

determining power levels associated with said plurality of signal wavelengths; and

adjusting variable currents of said plurality of current sources utilizing in part said power levels associated with said plurality of signal wavelengths.

27. The method of claim 26 wherein said step of providing a plurality of gain elements includes providing an external cavity that is operable to provide feedback to said plurality of gain elements and to combine output beams from said plurality of gain elements to form said Raman pump.

28. The method of claim 27 wherein said external cavity comprises:

a collimating optical assembly;

a dispersive element; and

a partial reflector.

29. The method of claim 28 wherein said partial reflector is embedded in an optical fiber, wherein said external cavity further comprises:

a focusing lens being operable to focus an output beam into said optical fiber.

30. The method of claim 29 wherein said dispersive element comprises at least one item from the list of:

reflective diffraction grating;

transmission diffraction grating;

prism; and

hologram.

31. The method of claim 28 further comprising the step of:

adjusting divergence of each output beam from said plurality of gain elements.

32. The method of claim 31 wherein said step of adjusting divergence is performed by an array of micro-lenses.

33. The method of claim 26 further comprising:

initiating respective current changes to selected ones of said plurality of gain elements; and

measuring resulting changes in power levels associated with said plurality of signal wavelengths for each respective current change to selected ones of said plurality of gain elements.

34. The method of claim 33 further comprising:

building a differential gain matrix, wherein said differential gain matrix relates a change in power levels associated with said plurality of signal wavelengths to a change in power associated with plurality of gain elements.

35. The method of claim 33 further comprising the step of:

inverting said differential gain matrix to produce an inverted matrix.

36. The method of claim 35 further comprising the step of:

multiplying said inverted matrix by a desired power level change vector.

37. The method of claim 26 further comprising the step of:

storing patterns of current levels to implement a learning algorithm.

38. The method of claim 26 further comprising:

applying a number of current combinations to said plurality of current sources to determine optimal current levels.

39. A system for providing Raman gain to a plurality of signal wavelengths, comprising:

a plurality of gain elements being operable to produce output beams;

a collimating optic being operable to focus said output beams on a dispersive element;

said dispersive element being operable to combine said output beams as a Raman pump; and

a controller device being operable to cause said plurality of gain elements to operate at variable levels in response to received information indicative of Raman gain produced by said Raman pump on said plurality of signal wavelengths.

40. The system of claim 39 further comprising:

an array of micro-lenses being operable to adjust divergence of said output beams from said plurality of gain elements.

41. The system of claim 39 further comprising:

an optical fiber;

a partial reflector being operable to reflect a portion of said Raman pump as feedback for said plurality of gain elements, wherein said partial reflector is embedded in said optical fiber; and

a fiber coupling lens for coupling said Raman pump into said optical fiber.

42. The system of claim 39 further comprising:

a spectrum analyzer being operable to determine power levels associated with said plurality of signal wavelengths and being operable to provide said information indicative of Raman gain to said controller device.

43. The system of claim 39 further comprising:

a linear detector array;

a focusing lens being operable to focus beams of the plurality of signal wavelengths being amplified diffracted from said dispersive element onto said

linear detector array to provide said information indicative of Raman gain to said controller device.

44. The system of claim 39 further comprising:

a partial reflector, said partial reflector being operable to partially reflect said output beams toward said dispersive element as reflected beams;

said dispersive element being operable to produce zero order diffracted beams from said reflected beams;

a focusing element being operable to focus said zero order diffracted beams onto a detector; and

said detector being operable to provide information indicative of an amount of optical power coupled into said optical fiber to said controller device.

45. The system of claim 39 wherein said controller device includes means for varying said Raman pump to maintain substantially spectrally flat Raman gain.

46. The system of claim 45 wherein said means for varying said Raman pump includes means for building a differential gain matrix, wherein said differential gain matrix relates changes in power levels associated with said plurality of gain elements to changes in optical power at said plurality of signal wavelengths.

47. The system of claim 45 wherein said means for varying said Raman pump includes means for multiplying said differential gain matrix by desired signal wavelength power changes.

48. The system of claim 45 wherein said means for varying said Raman pump includes means for storing patterns of currents applied to said plurality of gain elements, said patterns of currents applied to said plurality of gain elements being generated by a learning algorithm.

49. The system of claim 45 wherein said means for varying said Raman pump includes means for applying a plurality of current combinations to said plurality of gain elements.